UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

October 14, 2016

Rebecca A. Sawyer
Vice President, Sustainability
Excelsior Mining Arizona, Inc.
2999 North 44th Street, Suite 300
Phoenix, AZ 85018

RE: Request for Information
Class III Underground Injection Control Well Permit Application
Excelsior Mining Arizona, Inc.

Dear Ms. Sawyer:

The United States Environmental Protection Agency, Region IX (EPA) is conducting a technical review of the February 2016 Underground Injection Control (UIC) Permit application for the proposed Gunnison Copper Project, Cochise County, Arizona. We have reviewed the revised Class III UIC Permit application dated March 2016 for the proposed project. In order to continue our evaluation of your application materials, we are requesting additional information and clarifications as detailed in the enclosure.

Please address all items noted in the enclosure by submitting two copies of a complete revised application in hard copy and in electronic format. Please submit the information requested in this letter to:

Attn: Nancy Rumrill
U.S. EPA Region IX, (WTR-3-2)
75 Hawthorne Street
San Francisco, CA 94105

If you have any questions regarding this letter, please contact me at 415-972-3971 or call Nancy Rumrill at 415-972-3293.

Sincerely,

David Albright
Manager, Drinking Water Protection Section

Enclosure
cc w/enc.: Jerry Smit, ADEQ (via e-mail)

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ENCLOSURE

Request for Additional Information

Excelsior Mining Arizona Gunnison Copper Project, Class III UIC Permit Application

October 14, 2016

See the referenced attachment and section of the UIC Permit application for each comment and requested information.

1. *The application does not include a smaller-scale ISR test phase that would demonstrate hydraulic control and aquifer restoration under the proposed operational conditions, and would allow for real-world test results to calibrate the model predictions and fine tune the rest of the commercial operations. Please modify the permit application to account for operation of an initial pilot-scale test phase and EPA review of the test phase performance prior to full implementation of the proposed commercial-scale ISR operations. Alternatively, we will need to discuss how such initial demonstrations, analyses, and model confirmation/recalibration will be accomplished and provided to EPA for review and approval.*

Attachment A, Area of Review Method, Groundwater Modeling Report, Aquifer Testing Report

Section 3. Hydrogeologic and Operational Considerations

3.1.1 Site Specific Characteristics, Unsaturated Basin Fill.

2. The application states that the basin fill sediments overlying the injection zone do not meet the definition of an underground source of drinking water because they do not contain a "sufficient quantity of groundwater to supply a public water system." Drilling reports indicate that two or three wellbores encountered groundwater in the basin fill sediments, but the depths to the saturated intervals are not provided.

   Please provide additional information on the occurrence of saturated basin fill, including the basis or method for detecting the presence of water saturation and the depths and lateral extent of the occurrence of saturation as depicted on geologic cross sections and maps. Please show the cross sections of the basin fill saturation in proximity to the proposed injection zone saturation. Please provide a discussion of the data and calculations that support the contention of an insufficient quantity of groundwater to supply a public water system. [See discussion of Wells NSH-006 and NSD-020 in Attachment N-1, page 4 and Well NSH 011 in Attachment S-2, page 3 of the Haley and Aldrich Well Completion Report.]

3.1.2 Low Conductivity Sulfide Zone.

3. Estimated K values in the sulfide zone range from 0.001 to 0.1 ft. /day, based on aquifer pumping tests in two wells performed in 2015. The application states that "the sulfide zone is considered not feasible as an aquifer for a public water supply, and it provides a site specific control on the vertical migration of injected solutions." The K values vary by two orders of magnitude, and the presence of near vertical faults that transect the sulfide-oxide transition zone raises questions about those statements. The faults and associated fractures could provide conduits for vertical migration of injected fluids between zones.

   Please provide a more detailed assessment of the sulfide zone as an underlying confining zone and aquiclude to the oxide zone, and its suitability as the lower boundary of the proposed aquifer exemption, taking into consideration the variability of K values and faulting noted above.

3.2.1 Hydraulic Gradients.

4. The application states that "the total rate of pumping from the in-situ recovery wells and hydraulic control wells will be adjusted and maintained to exceed the total rate of lixiviant injection." The application states elsewhere that recovery and injection volumes will be maintained in balance within the wellfield, while over-extraction will be achieved by the perimeter hydraulic control wells. The underground injection control (UIC) permit will require a minimum ratio of fluid withdrawals to injection rates and volumes in the wellfield, subject to possible adjustment based on monitoring of ISR performance, inward gradients at the observation well pairs, specific conductance data from the observation wells, and EPA approval.

   Please provide a discussion of the minimum extent of over-pumping necessary to maintain hydraulic control of injected fluids, based on model simulation results.

5. The placement of hydraulic control (HC) wells, as discussed on page 6 and depicted in Figure A-7, may not be adequate. Additional HC and observation wells may be required at the western AOR boundary, based on sensitivity analysis of the groundwater flow model of a potential undetected loss of hydraulic control and possible excursions of lixiviant beyond the ISR wellfield.

   Please revise this section in consideration of the sensitivity analyses and propose installation of additional HC and observation wells as requested in the comments on the Groundwater Modeling Report below.

6. *With consideration to the reference to "higher natural west-to-east hydraulic gradient" as depicted in Figure A-4, please provide an estimate of the natural groundwater flow velocity at the project site.*

3.2.2 Injection Flow.

7. *A minimum inward hydraulic gradient at each observation well pair to maintain hydraulic containment should be established during initial operations, based on the statistical analysis of the normal variation of observation well data. The minimum net fluid withdrawal to injection ratio will be based on the ratio necessary to maintain the minimum inward hydraulic gradient at all observation well pairs. Please provide a discussion of the procedures to be applied in this analysis.*

8. The proposed 30-day rolling average basis for operation of the wellfield and maintaining the balance of fluid injection and recovery well volumes is not sufficient.

   The volume balance will need to be monitored and maintained on a daily basis. Please address in your revised application.

9. *Please propose a specific value for the minimum inward hydraulic gradient to be maintained around the active portions of the ISR wellfield, including portions undergoing restoration, subject to review and adjustment based on statistical analysis of the observation well data.*

3.2.4 Borehole Abandonment.

10. Plugging and abandonment (P&A) of improperly abandoned wells or boreholes may be required as a permit condition if vertical movement of ISR fluids into the basin fill sediments could occur in those wells or borings during ISR operation. Injected fluids must be contained within the permitted injection interval, even if there is no USDW within the AOR. ISR fluids that escape into the basin fill could migrate into a USDW located within the much thicker and saturated basin fill sediments less than ¼ mile downgradient and east of the wellfield. Figure 9 in Attachment A-2 shows the saturated basin fill thickness increases from less than 100 feet under the project area to 1,100 feet approximately one mile to the northeast of the eastern boundary of the proposed AOR.

    Please consider this issue and provide an analysis and discussion.

3.2.6 Mechanical Integrity Testing.

11. The statement on page 8: "Part 2 mechanical integrity will not be conducted..." is not accurate. ISR fluids must be contained within the permitted injection zone even if there is no USDW located above or below the injection zone, as discussed above.

    Please revise the application to state that part 2 mechanical integrity testing/evaluation will be conducted in all Class III wells, including injection, recovery, hydraulic control, observation, and point of compliance (POC) and other monitoring wells located within the AOR.

3.2.7 Rinsing.

12. *Please revise the last sentence on page 8 to read: "and all regulated constituents are at or below aquifer water quality standards (AWQSs)* ***and UIC permit water quality standards.*** *"*

    Please revise the second sentence in paragraph 2 on page 9 to add that "Samples will be collected from all recovery wells within the mining block after the third step."

    Please revise the last sentence in paragraph 2 on page 9 to read: "Analysis will be conducted for APP ***and UIC permit*** *regulated metals (dissolved), sulfate, TDS, pH, and specific conductivity."*

    *Please revise the third paragraph to add "****and UIC permit****" after "under the APP"*

    *Please revise the first sentence in the fourth paragraph to add "****and EPA****" after "submitted to ADEQ."*

    *Please revise the last sentence in the fourth paragraph to add "****and EPA****" after "without approval from ADEQ."*

3.2.7.2 Well Plugging and Abandonment.

13. *Please revise the first sentence to add "****and the UIC permit****" at the end of that sentence.*

Section 4. Area of Review

4.3 AOR Delineation.

14. Fig A-7 Area of Review and Well Locations map omits the planned injection and recovery well locations.

    Please include the planned injection/recovery well locations on this map so that the proposed locations of the POC, HC, and observation wells can be viewed in relationship to the planned ISR wellfield locations.

15. The second paragraph states that the proposed western boundary of the AOR is coincident with the property boundary and is *only* 100 feet from the nearest injection wells. The eastward hydraulic gradient is expected to exceed the injection flows to the west, but the gradient and groundwater velocity values are not provided. Moreover, no hydraulic control or observation wells are proposed at the perimeter of the western AOR boundary and wellfield perimeter. If hydraulic containment were lost to the west, that loss would go undetected without HC and observation wells located at the western AOR boundary. The groundwater flow model results show containment at the western boundary, however, due to the heterogeneity and highly faulted structure of the orebody, this modeled outcome cannot be assured during actual ISR operations.

Please provide additional proposed HC and observation wells at the western perimeter of the AOR to ensure containment of ISR fluids. The spacing of the HC wells at the western AOR boundary should be similar to the spacing of the proposed HC well locations at the eastern and southern wellfield boundaries unless the applicant can demonstrate that fewer HC wells would suffice. Please perform and consider a simulated loss of HC for at least 30 days at the western boundary in the assessment.

16. *Please discuss and justify the rationale for the spacing and number of HC and observation wells at the wellfield perimeter.*

17. *Please discuss and justify the rationale for the spacing and number of POC or monitoring wells at the AOR perimeter.*

18. Figure A-5, Geologic Cross Section A-A', depicts the potentiometric surface at an elevation of approximately 50 to 100 feet above the bedrock surface and within the basal fill sediments underlying the wellfield and western extent of the AOR. In addition, Figure D-4, Geologic Cross Section B-B' in Attachment D, depicts the potentiometric surface at an elevation of up to approximately 100 feet above the bedrock surface and within the basin fill sediments underlying the northern portion of the AOR.

    Please clarify whether this represents water saturated sediments in the unconfined basin fill or the hydraulic head of the bedrock aquifer. If the former, the saturated lower basin fill sediments could be considered a USDW if capable of supplying a public water system.

19. The apparent absence of an aquitard or confining layer at the bedrock-basin fill contact and the presence of near-vertical faults in the bedrock at the contact would indicate a hydraulic connection exists between the bedrock and basin fill sediments.

    Please provide clarification and an assessment of the hydraulic connection between the basin fill and bedrock aquifer.

Attachment A-2, Groundwater Modeling Report

Groundwater Model

<u>2.5.1 Aquifer Systems</u>.

20. The application states that "[t]he basin fill aquifer is used for water supply in the Dragoon area, and also historically for the Johnson Camp Mine, north of the Site." The Dragoon area is about 3.5 miles due south of the project site, in an area where the basin fill saturation is 100 feet or greater in thickness according to the saturation thickness contours in Figure 9 and the map of hydraulic conductivity based on specific capacity depicted in Figure 13. The Johnson Camp Mine site is approximately 1.5 miles northwest of the project site and also in an area where the saturation thickness is mapped as less than 100 feet in figure 13.

Since the basin fill saturated thickness at the Johnson Camp Mine (JCM) site is comparable to the saturated thickness in two test wells at the project site and the basin fill well(s) at the JCM site are productive but currently inactive, please explain why the basin fill saturated thickness at the project site is not considered a USDW.

21. The apparent hydraulic connection with the bedrock aquifer appears to classify the basin fill saturation as part of the bedrock aquifer.

    Please justify why the basin fill saturation should not be classified as a portion of a USDW, whether it be the bedrock USDW, or the basin fill USDW depicted in Figure 9 as less than ¼ mile to the north or east of the wellfield perimeter.

<u>2.5.2 Groundwater Movement and Boundary Conditions.</u>

22. The application indicated that the recharge calculations are based on the assumption that approximately 3% of available precipitation recharges the aquifer, with the assumption based on information from other similar modeling studies. No references to those other modeling studies were provided.

    Please provide the citations to (or copies of) those modeling studies that were the basis of the assumptions used in the recharge calculations.

<u>2.5.3 Regional Groundwater Levels and Flow Directions.</u>

23. It was indicated that the Johnson Camp mine has been operating in a limited capacity since 2010 and that only a minimal amount of ground water pumping is conducted at that site. Since the project site is located only 1.5 miles to the north of the Gunnison Copper project (according to page 1 of the application), and the full capacity pumping rate at Johnson Camp mine is as high as 600 gpm, the operation of that mine during the life of the project (23 years) should be considered as an influence in the project site groundwater conditions.

    Please either provide more information on the Johnson Camp operations to ensure that the pumping rate would be minimal during the life of this project and/or conduct a sensitivity analysis that would incorporate the effects on groundwater flow due to pumping and operations at the Johnson Camp. Please include the description of the sensitivity analysis data and results.

<u>2.5.5 Hydraulic Properties-Tests at the Gunnison Copper Project.</u>

24. On Attachment A-2 pages 14 and 15, Table 8, Figure 13, and Figures 21 to 27, a variety of hydraulic conductivity values for the basin fill are presented, and there appears to be no agreement in the reported maximum hydraulic conductivity value. For instance, on page 15 a range of 45 to 0.12 ft/day is noted, the maximum value in Figure 13 is 4.2 ft/day, the maximum value in Table 8 is 12.5 ft/day, and in Figures 21-27, the maximum value is 10 ft/day.

Please provide and describe the maximum hydraulic conductivity values for the basin fill measured at the project site.

4.2 Model Domain and Model Gird/Layering.

25. *Please provide more explanation regarding how the 7 model layers were selected and how they correspond to the 10 main geologic units identified in Attachment A-2, pages 5 and 6.*

4.4 Hydraulic parameters.

4.4.1 Hydraulic Conductivity

26. *Please discuss the basis for the 1:50 vertical to horizontal ratio of hydraulic conductivity for the basin fill applied in the model.*

4.4.2 Storage values.

27. The applicant plotted the measured porosity and interpreted fracture intensity values in Figure 28 and used the average porosity value for each fracture intensity group. Because of the large variation of porosity values in each fracture intensity group, the average value might not be a good representation of actual conditions.

    Please conduct a sensitivity analysis for porosity to study the effect of porosity variation on model prediction. Please provide the description of the sensitivity analysis data and results.

4.9 Model Sensitivity.

28. *Please perform simulations for undetected loss of hydraulic containment during ISR operations in the basin fill aquifer, including model layer 2. Also, perform simulations of groundwater flow during the post closure period assuming rebound of contaminants occurs after rinsing and closure operations are completed and residual contaminants migrate downgradient into the non-exempt portion of the bedrock and basin fill aquifers.*

29. On Attachment A-2, page 23, it notes that the most sensitive zone is Kx4 and the second most sensitive zone is Kx10. However, Figure 41 shows higher values for Kx10 than Kx4 which indicates that Kx10 is the most sensitive zone.

    Please clarify this issue and provide information that identifies the most sensitive zone.

30. It is not clear from the application if the vertical-to-horizontal ratio of hydraulic conductivity has been changed when Kx and Kz values changed or kept constant.

    Please clarify any effects on the vertical-to-horizontal ratio with respect to any changes in Kx and Kz values.

31. *Because of the heterogeneity and highly faulted structure of the orebody and uncertainty associated with important parameter values (e.g. porosity, permeability, recharge), please*

conduct additional simulations with more conservative values for the life of the ISR and rinsing operations and during the post closure period. Please provide a discussion and description of the data and results.

Model Predictions

5.1 Hydraulic Control Simulation.

32. *Please simulate the post-rinsing and closure period to assess groundwater flow and time of travel for an undetected contaminant to reach the POC wells and the USDW beyond the aquifer exemption boundary in the bedrock aquifer and into the basin fill aquifer downgradient of the project site. Please provide a discussion and description of the data and results.*

5.1.2 Hydraulic Control Wells.

33. Regarding Figure 45 referenced in this discussion, the Mining Block Sequence Map in Figure 45 shows only three active HC wells in year 1, located about 1,000 feet due east of the initial mining block and at the ultimate wellfield perimeter. The model shows the predicted drawdown contours for those three HC wells (in layer 4) in Figure 48.

    Please clarify installation of the HC wells in the year of activation or at the inception of the project. Additional wells should be installed and activated along the eastern and southern perimeter during year 1 to ensure total containment of ISR fluids in year 1. Please clarify the schedule for installation of HC wells and associated observation wells and present a schedule for the drilling and activation of HC and observation wells that will ensure full containment of ISR fluids during ISR and rinsing operations. At a minimum, EPA recommends that the HC wells shown activated in year 7 through year 13 in Figure 45 (19 wells) be installed and activated at inception of the ISR operation in year 1.

5.1.3 Particle Tracking.

34. The application indicated that because of the slow movement of particles across the mining area, particles are first released six years after mining starts. Due to faulting and fracturing in site geology, it is possible that ISR fluid could move faster through fractures (secondary permeability features) in some parts of the site.

    Please justify particle release time and consider an earlier release time (a more conservative approach) given possible fracture flow in places at the site.

5.2.2 Capture Analysis.

35. Figures 58 and 59 show some particles leaving the wellfield area and possibly leaving the AOR on the west side of the site. Due to uncertainties mentioned in comment 31, the presence of faults and fractures, and nearby pumping wells (as seen in Figure 10), it is possible that these particles may travel further from the AOR boundary.

Please assess and describe whether or not installation of monitoring or POC wells is necessary in this area and whether an extension of the AOR boundary is needed.

Table 5, Well Information for Project Area.

36. *Please discuss the purpose of the many Env-Monitor wells or piezometers listed on this table. Also, please identify the zone(s) in which each well is open: basin fill, oxide bedrock, sulfide bedrock, or other zone/aquifer.*

Figure 16, Comparison of Fracture Intensity to Hydraulic Conductivity Data.

37. *Please provide the R^2 (R squared) to present the goodness of the fit of the model.*

Figure 18, Geologic Cross Section C-C'.

38. The C-C' cross section shows the model layers 1 through 7 in a west to east section and the location of the wellfield relative to the underlying strata and major faults.
Please present Geologic Cross Sections A-A' and B-B' with the seven model layers shown as depicted in Cross Section C-C'.

Figure 45, Mining Block Sequence Map.

39. *Please revise the mining block sequence map to show the additional active hydraulic control wells discussed in comment 33 above.*

Figures 48 to 56.

40. These figures depict results of model drawdown predictions as wellfields are developed and ISR and rinsing operations proceed through year 23.

    Please modify the figures to show the locations of the active injection and recovery wells relative to the drawdown contours at the year indicated in each figure.

Attachment B, Maps of Well/Area and Area of Review

41. The map provided in Figure B-2 shows the location of wells within ½ mile of the AOR but does not include the number and name of each well. The well numbers but no names are shown for six water supply wells. A large number of exploration or environmental monitoring wells are posted on the map, but the status of each well is not indicated on the map or in well information tabulations in Attachment A or B.

    Please provide the name, number, and status (i.e., active, inactive, abandoned, etc.) of all wells within the AOR on a map (larger scale than presented in Figure B-2) and in the tabulations in Table B-1.

42. The information provided on page 2 indicates that there are no known abandoned wells in the project area.

Please explain why the wellbores identified as inactive have not been plugged and abandoned.

43. *Please provide additional information for the six water supply wells (also identified as public water systems) shown on the map of the area and listed on table 5 in Attachment A, including the aquifer(s) in which the wells are completed, the status of each of those wells, and the yield of each active well.*

44. The proposed POC wells are located beyond the proposed AOR and aquifer exemption boundary, which would place them in the non-exempt portion of the aquifer.

    Please propose installation of monitoring wells (also known as POC wells) within the AOR and AE boundary in order to detect and reverse an excursion before it reaches the USDW downgradient of the boundary. Propose additional monitoring wells placed downgradient of the wellfield and at the western and southern limits of the AOR to fully protect the USDW from excursions beyond the AOR and AE boundaries. Monitoring wells, pursuant to 40 CFR §146.32(e), shall be located to detect any excursion of injection fluids, process by-products or formation fluids outside the mining area or zone. To determine monitoring locations, EPA will consider the directional permeability of the faults and fracture system, which could result in fluid flow upgradient of the wellfield or between widely spaced POC wells that modeling cannot predict due to its inherent limitations in such a complex geologic environment.

45. *The directional permeability of the faults and fracture system could result in fluid flow upgradient of the wellfield or between widely spaced POC wells that modeling cannot predict due to its inherent limitations in such a complex geologic environment. To address this concern, EPA recommends expanding the AOR and aquifer exemption limits, assuming that you can demonstrate that the expanded portion will meet federal criteria for the exemption, beyond the wellfield perimeter at the proposed southern and western boundary by at least 500 feet to provide a buffer zone for a potential temporary loss of hydraulic containment and excursion of ISR fluids during ISR and rinsing operations.*

Attachment C, Corrective Action Plan and Well Data

1. Introduction

46. The applicant presents the basin fill above the oxide orebody as not an underground source of drinking water because there are only isolated occurrences of saturated basin fill within the proposed AOR, and the basin fill does not contain a "sufficient quantity of groundwater to supply a public water system". The application does not provide sufficient information to support that position, as discussed above under Attachment A comments. The saturated thickness contours of the basin fill aquifer, as depicted in Figure 9 in Attachment A, appear to extend to a point within the eastern limit of the proposed AOR boundary, which would indicate that at least a portion of the basin fill USDW is present within the AOR. In

addition, saturated thicknesses of 30 to 40 feet at the base of the basin fill were reported in two wells located within the AOR.

As requested in comment 2, please demonstrate why the basin fill saturation should not be classified as a portion of a USDW, which is the uppermost limit of the USDW from the underlying bedrock, or an extension of the basin fill USDW as depicted in Figure 9. Please modify the language in Attachment C to be consistent with your demonstration.

2. Wells within the Area of Review

47. Table C-1. *Please include in the table the date drilled and the record of construction, completion, plugging, and status of each well, or reference to that information if it is provided elsewhere in the application.*

48. Figure C-1, Well Locations within the Area of Review. *Please identify the exploratory and environmental wells on this map.*

Attachment D Maps and Cross Sections of USDWs

1. Underground Source of Drinking Water

49. The application states that "the deeper bedrock (sulfide zone) is not a USDW…." because two aquifer tests conducted in the sulfide zone in wells NSH-14B and NSH-025 indicated low hydraulic conductivity values of 0.01 and 0.07 feet/day, respectively. However, discussion in Sections 2.6.1 and 2.6.2 of Attachment A-3, Aquifer Testing Report, states K values of 0.001 for the NSH-14B well and 0.1 feet/day for the NSH-025 well.

    Please provide clarification of the different K values reported in Attachments A and D.

50. These K values represent a range of up to two orders of magnitude and the highest K value of 0.1 ft/day could be considered as borderline productive. Furthermore, the presence of vertical faults extending from the sulfide zone into the oxide zone above provide a transmissive hydraulic connection between zones. There is no lithologic boundary between the oxide and sulfide zone and the only barrier to flow between zones is the lower intensity fracturing in the sulfide zone relative to the oxide zone. Consequently, the information in the application does not provide an adequate demonstration that the sulfide zone is not a USDW and not hydraulically connected to the above Oxide USDW.

    Because of the lack of an adequate demonstration, EPA will require installation of monitoring wells installed in the sulfide zone in close proximity to a vertical fault zone and additional logging and testing to demonstrate the absence of a USDW in the sulfide zone within the AOR. Please revise the application accordingly.

51. *EPA will require an exclusion zone in the lower as well as the upper portion of the oxide zone and over-pumping the recovery wells to maintain an inward hydraulic gradient in the*

wellfield and ensure containment of ISR fluids to the oxide zone at the wellfield. Please revise the application to include implementation of these conditions.

52. According to the applicant, the Tertiary Texas Canyon Quartz Monzonite is not a USDW based on its hydraulic properties, but there is insufficient information and discussion of the unit to demonstrate that it is not a USDW within the western portion of the AOR. The Bedrock Surface Geologic Map in Figure D-2 shows extensive thrust faulting in that unit within the southwestern boundary of the AOR, which could provide sufficient transmissivity and connectivity with the oxide zone and basin fill sediments to allow exchange of fluids.

    Please provide additional information to support that the Texas Canyon Quartz Monzonite unit is not a USDW and not in hydraulic communication with a USDW.

Figures D-3, D-4, and D-5, Geologic Cross Sections

53. The geologic cross sections depict the vertical extent of the USDW in the AOR, from the top of sulfide zone upward to the lower of the top of the oxide bedrock zone or the top of the saturated zone within the oxide zone.

    Please provide geologic cross sections of geophysical logs and/or cores on which these schematic cross sections are based.

Attachment F, Maps and Cross Sections of Geologic Structure of Area

Figures F-3, F-4, and F-5, Geologic Cross Sections

54. *Similar to Comment 53 under Attachment D above, please provide geologic cross sections of geophysical logs and/or cores on which these schematic cross sections are based.*

Attachment H, Operating Data

2. Description of Operations.

2.1 Process Description

55. The application states that aquifer testing will be performed at installation, and used to determine layout and number of recovery wells.

    Please provide additional information on the aquifer testing plan for EPA review and approval.

56. *Please include on Figures H-1 and H-2 the proposed arrangement of injection and recovery wells in the planned wellfield, and provide the modified wellfield arrangement plan proposed for implementation after aquifer testing is completed and evaluated. In addition, please add the additional HC, observation, and POC wells discussed in the above comments to Figure H-2.*

2.2 Injection Rates

57. *Please show the method for calculation of the average and maximum injection rates discussed on page 3 of Section 2.2 and indicate the number of active injection wells in each stage of operations. Also, provide the estimated average and maximum injection rates per well.*

58. Hydraulic control wells at the perimeter will draw fluids away from the wellfield unless the extraction wells withdraw more fluids than are injected. It is not clear that the proposed operations provide for extraction rates that exceed injection rates within the wellfield. In fact, it appears that injection volumes could exceed extraction volumes in the wellfield as long as the pumped volumes from HC wells exceed or are in balance with the net injection volumes in the wellfield. This situation could produce an outward flow from the wellfield to the HC wells or upgradient beyond the AOR, neither of which, would be acceptable.

    The revised application should include a proposed minimum net extraction to injection ratio or percentage within wellfields as a means to maintain hydraulic control of ISR fluids in addition to pumping from the HC wells. Please design the ISR operations and groundwater model to provide and simulate containment of ISR fluids to the wellfield as it expands during the life of the project, not merely to the ultimate wellfield planned for year 21.

59. The proposed 30-day rolling average of the total volume of injected fluids not exceeding the 30-day rolling average of the total volume of pumping from recovery wells and hydraulic control wells is not adequate.

    EPA will require you to maintain the excess recovery volume on a daily average basis. If the average extracted-to-injected volume ratio of fluid falls below the required minimum extraction to injection volume ratio in any 48-hour period, we will require the extraction rate to be increased and/or the injection rate decreased to regain the required minimum volume ratio within the next 24-hour period.

60. The proposed observation wells will monitor the inward gradient to the HC wells. However, the gradient will be away from the wellfield(s) toward the HC wells unless extracted volumes in the wellfields are sufficient to exceed the drawdown of the HC wells and the outward flow gradient of the injection wells.

    Please clarify the statement: "[a]n inward gradient will be maintained around the active portions of the wellfield, as measured in observation wells located near the hydraulic control wells (Figure H-2).

3. Injection Pressure

61. EPA will likely require step-rate testing of a representative number of injection wells in each mine block to provide better and more representative estimates of the formation fracture pressure at the top of the injection interval and to establish a maximum allowable injection pressure for each injection well in a mine block.

The revised application should modify your description, accordingly, in Attachment H and I under Fracture Pressure. Permit conditions will require continuous monitoring and daily recording of injection pressures.

4. Nature of Annulus Fluid

62. Annulus fluid refers to the fluid in the annulus of injection wells with packers installed, as in Figure M-3 in Attachment M.

    Please specify the type of fluid that will be placed in the annulus of injection wells with steel casing, which require packers and noncorrosive annulus fluid.

4.1 The Evolution of the Process Solution Chemistry during Mine Operations

63. *Please add: "and EPA water quality standards" after "Arizona AWQSs" in the last paragraph of this Section on page 6.*

Table H-1, Forecast Composition of In-Situ Recovery Process Solutions

64. *Please add a column for EPA Maximum Contaminant Levels (MCLs).*

65. *Please explain why concentrations are shown in mg/kg instead of mg/l for all process solutions except makeup or rinse water.*

Attachment I, Formation Testing Program

2. Fluid Pressure

66. Figure I-2, Potentiometric Surface in Relation to Bedrock, excludes many of the wells posted in Figure I-1, Depths to Groundwater. The data for those omitted wells in Figure I-2 is of interest for assessing water levels and the extent of possible water saturation in the basin fill in those wells.

    Please provide those data for the omitted wells in Figure I-2 and provide the location of the discussion that supports the statement (on page 2 of this section): "most negative numbers are indicative of confined conditions, not saturated alluvium (which is discussed below)".

4. Chemical Characteristics of Formation Fluids

67. Reference is made to the Arizona DEQ aquifer water quality standards (AWQS) throughout this section, but not to federal MCLs for drinking water quality.

    The revised application should reference federal MCLs wherever reference to AWQS is provided and state the MCL when it differs from the AWQS stated in the discussion of a particular constituent.

4.5 Groundwater Quality in the Vicinity of the Project

68. *The water quality data for the Johnson Camp Mine (JCM) POC wells are considered relevant to the Gunnison Copper ISR Project. Please provide the data in the UIC application. In addition, provide the location and identity of the JCM POC wells and show them on Figure I-7, Potentiometric Surface Map.*

69. *Please revise Tables I-1, I-2, I-3, and I-4 to add a line for federal MCLs for all listed constituents.*

Attachment I-2, Fracture Gradient Testing and Analysis

70. The fracture pressure tests and analysis provided for six boreholes in the project area are useful, but the location of each of the boreholes is not provided in Attachment I-2.

    Please include a map showing the location and identity of each of the six boreholes in relation to the project site area.

Attachment K, Injection Procedures

2. Description of Operations

2.2 Injection Process

71. *Please clarify in the application the frequency at which injection pressure will be recorded manually and entered electronically to the data loggers in the last paragraph of this section on page 3.*

Figure K-1, Schematic View of Wellfield Layout

72. The schematic shows only one observation well instead of two observation wells to measure the inward hydraulic gradient created by the perimeter hydraulic control wells, and two of the three observation wells in the layout are located between perimeter wells instead of being paired with and opposite a perimeter well as depicted in Figure A-7 in Attachment A.

    Please revise the schematic view to be consistent with the wellfield layout shown in Figure A-7 as modified in response to comment 4 above regarding the installation of additional hydraulic control and associated observation wells in Attachment A.

Figure K-2, Site Plan

73. *Please enlarge the proposed AOR boundary to be consistent with the response to comments on Attachment A, regarding expansion of the AOR, and modification of other figures in the application showing the proposed AOR boundary.*

Attachment L, Construction Procedures

1. Introduction

74. *Regarding the discussion in the last paragraph on page 1, please include monitoring (POC) well locations within the AOR boundaries and construction to meet Class III injection well requirements.*

75. Well designs for injection, recovery, and hydraulic control wells are not identical, as stated in the last paragraph on page 1. The description of well construction design plans under Section 2, Drilling and Construction that follows, and the well schematics in Attachment M indicate proposed well designs that vary significantly.

    For clarification, please revise the description to note that planned well designs vary as described in Section 2 and depicted in the well schematics in Attachment M.

    Please revise the last sentence of the last paragraph to state that the depths of the well screens to be installed in the observation and POC wells will be equivalent to the open-hole or screened completion intervals in the nearest injection, recovery, and hydraulic control wells.

2. Drilling and Construction

<u>2.1 Surface Casing</u>

76. *Please justify the planned removal of surface casing upon well completion.*

<u>2.3 Casing</u>

77. *Please discuss the reasons and circumstances applicable to the planned use of polyvinyl chloride (PVC), fiberglass-reinforced plastic (FRP) and/or low carbon steel (LCS) casing and the circumstances applicable to the various well diameters and designs proposed by the applicant.*

<u>2.4 Leak Detection Conductivity Probes</u>

78. Installation of annular conductivity devices will be required in injection wells constructed with FRP casing and cement bond logs required in wells constructed with steel casing to monitor and reduce the potential for vertical fluid movement in the cemented annulus of injection wells. As previously noted, ISR fluids must be contained within the injection zone even if there are no USDWs above and/or below the injection zone. If ISR fluids were to migrate vertically out of zone, they could then migrate horizontally into the non-exempt portion of the oxide zone aquifer or the basin fill USDW. The saturated portion of the basin fill within the AOR may be classified as a USDW or as a portion of the USDW present in the oxide zone, depending on the review and evaluation of additional information requested.

The revised application should address any risk to USDWs located beyond the exempted zone. It should also include proposed details for installation of annular conductivity probes in FRP-cased wells to monitor for significant fluid movement through vertical channels in the cemented annulus and for CBLs to be run in steel cased wells to detect poorly bonded cement and vertical channels in the cemented annulus. These requirements will be included as UIC permit conditions.

2.5 Annular Materials Program

79. Given the uncertainty regarding the presence or absence of a USDW above and below the injection zone, as discussed above, the casing should be set and cemented at least 40 feet below the bedrock-basin fill contact and cemented to at least 100 feet above the higher of the contact or the top of the saturated interval in the basin fill to create a 40-foot exclusion zone and a separation interval at the bedrock/basin fill contact.

    The revised application should modify the well construction description, accordingly.

80. EPA has concerns about the removal of surface casing and filling of the long string casing basin fill annulus with cement as described on page 4. For example, is the basin fill sufficiently consolidated to avoid collapsing into the void after removal of surface casing? We recommend that the surface casing be left in place and placement of cement between the surface casing and long string casing from 20 feet to the ground surface to provide a stronger well support structure and isolation of the well annulus from leaking ISR or PLS fluids at the surface.

    The revised application should either clearly justify removal of surface casing or modify the application as recommended.

3. Logging Procedures

3.2 Geophysical Logging

81. *Please specify the type of electrical logs that will be run and clarify whether the open hole logs will be run from total depth to the surface casing before long string casing is installed into bedrock. EPA will require running density logs in the injection wells in addition to the logs listed in this section.*

82. *Because cement bond logs are not applicable in PVC or FRP-cased wells, please specify that temperature logs will be run in casing of those wells instead of CBLs, and annular conductivity sensors will be installed in the cemented annulus as discussed above.*

83. *Note that permit conditions will require that copies of all logs are provided to EPA in a timely basis (e.g., within 30 days of completion).*

Attachment M, Construction Details

84. *Please discuss the circumstances applicable to the proposed small diameter and large diameter injection/recovery well designs in Figures M-1 and M-2, respectively, and the packer completion design in Figure M-3.*

85. *Please specify what circumstances might cause the use of the alternate well design using a combination of PVC and FRP well materials, as noted in Figures M-1, M-2, and M-4.*

86. *Please provide schematics for hydraulic control wells and POC and other monitoring wells.*

Attachment N, Changes in Injected Fluid

87. *In Section 2 of the Background, the revised application should specify the top of the injection zone as a minimum of 40 feet below the top of bedrock instead of just 20 feet, as described in comment 80 above.*

88. As previously noted, the upper portions of the sulfide zone could be considered a portion of the oxide zone USDW, dependent upon the review of additional information requested.

    Please consider the upper portions of the sulfide zone for inclusion in the proposed aquifer exemption zoned to avoid movement of ISR fluids into a possible USDW in the sulfide zone.

3. Aquifer Characteristics

3.1.2 Occurrence of Saturated Basin Fill

89. The E-log of well NSH-014B indicates a water level in the well at a depth of 20 feet and formation water at 50 feet in the basin fill unit, the bottom of which appears to be at about 500 feet deep. The location of this well is Section 31BCC-15-23, apparently within the AOR, but it is not located or identified on any map of the project site. The E-log indicates a saturated interval in the basin fill of at least 450 feet in thickness, which is far thicker and shallower than reported and may qualify as a USDW.

    Please identify the location of the NSH-014B well in Figure N-4 and explain the apparent discrepancy regarding the basin fill water saturation depth and thickness in this well and that reported in the text of the application.

90. The E-log of well NSH-022 indicates a water level in the well at 17 feet depth and formation water at 45 feet in the basin fill unit, the bottom of which appears to be at about 580 feet deep. The location of this well is Section 31CDC-15-23, apparently within the AOR, but is not located or identified on any map of the project site. The E-log appears to indicate a saturated interval in the basin fill of at least 535 feet in thickness, which is far thicker and at a more shallow depth than reported by the applicant and would definitely qualify as a USDW.

Please identify the location of the NSH-022 well in Figure N-4 and explain the apparent discrepancy regarding the basin fill water saturation depth and thickness in this well and that reported in the text of the application.

91. *Please discuss the proximity of the water saturation thickness in the NSH-006 and NSD-020 wells relative to the depth to saturation in the bedrock and clarify whether saturated intervals in those two wells are in contact with bedrock saturation.*

92. *Because the basin fill saturated intervals may be considered a USDW or a portion of the bedrock oxide zone USDW, consider including the basin fill saturated intervals in the aquifer exemption request.*

3.3 Hydraulic Parameters

3.3.1 Pumping Tests

93. The NSH-006 well is completed in the basin fill and produced at a rate of 3 gpm for one day with only 0.4 feet of drawdown, indicating good connectivity within the basin fill. The 33 feet of saturated basin fill is at the top of the bedrock at a depth of 684 feet according to the pump test report in Attachment A-3. One of five observation wells completed in the bedrock unit showed a clear response to the pumping at the NSH-006 well.

    Please discuss this data as an indication that the basin fill saturated interval in this well is in hydraulic communication with the bedrock aquifer and should be considered as a portion of the bedrock USDW.

3.3.4 Porosity

94. Core holes were drilled at the project site, but there is insufficient discussion or provision of core data and analyses in the application. Porosity and permeability data from cores could be of considerable value in comparison to other means used to estimate those parameters in addition to the fracture intensity analysis provided in Attachment F.

    Please provide the relevant core analysis reports for use in reviewing the overall application and the validity of the groundwater flow model.

4. Changes in Pressure of Injected Fluid

95. Two wells were pump tested in the sulfide bedrock zone with results that indicated hydraulic conductivities ranging from 0.001 to 0.1 ft/day, which is substantially lower than the oxide zone K-values determined from pump testing with an average of 1.1 ft/day and a range of 0.01 to 9.8 ft/day. Testing results in only two wells in the sulfide zone is not considered conclusive for the estimation of an average K value. Vertical faults that intersect the sulfide-oxide contact are depicted in cross sections presented in Attachment D. If the well completions were not in good connection with a fault zone, K values would be relatively low, as reported in these wells.

Please account for those considerations in the groundwater flow model and as a potential indication of the risk of ISR fluid migration into the unexempted sulfide zone.

6. Direction of Movement of Injected Fluid

96. The application states that "net withdrawal will be achieved by pumping of the hydraulic control wells." If the wellfield injection and recovery rates are in balance, as stated on page 11, the hydraulic control wells at the perimeter will tend to capture ISR fluids in the cone of their influence.

Please demonstrate how pumping to cause net withdrawal at HC wells will not cause ISR fluids to escape the mine block wellfields and reduce recovery of PLS fluids in the recovery wells. The recovery wells should extract more fluids than injected to contain ISR fluids to the wellfield as it is expanded over time. The perimeter HC wells would only be expected to serve as a contingency for loss of containment at the boundary of the ultimate wellfield perimeter.

Attachment O, Plans for Well Failures

1. Introduction

97. *The revised application should reference the UIC permit in addition to the ADEQ's APP for compliance with water quality monitoring requirements in the fourth paragraph on page 1.*

98. *Please insert "permit" after UIC in the fifth and sixth paragraphs on page 1.*

2. Contingency Plan Elements

2.1 Loss of Hydraulic Control

99. As noted above, the proposal to adjusting pumping rates so that injection volumes do not exceed extraction volumes on a 30-day rolling average basis is not adequate.

EPA will require monitoring of injection and extraction volumes and adjusting injection and/or extraction rates to maintain hydraulic control on a daily basis. Also, extraction volumes should always exceed injection rates to an extent that maintains an inward hydraulic gradient to the active mine blocks and overall wellfield. Please revise the application accordingly.

2.2 Well Failures

2.2.1 Mechanical Integrity:

100. *EPA will require Part 1 mechanical Integrity testing at least once every five years until a well is plugged and abandoned in accordance with UIC permit conditions. Please revise this section accordingly.*

101. *EPA will require Part 2 mechanical integrity testing to ensure containment of ISR fluids to the permitted injection zone as described above. Testing may include CBLs, temperature logs, radioactive tracer surveys, and/or monitoring of annular conductivity devices. Please revise this section accordingly.*

2.3 Operational Noncompliance

102. *Please revise the reference to "30 day rolling average" to "48-hour average," and "net pumping within the next 30 days" to "net pumping within the next 24 hours."*

Attachment P, Monitoring Program

2. Monitoring

2.1 Injected Fluids

103. *Please explain why radium and uranium would be monitored on an annual basis rather than monthly as proposed for the other constituents.*

2.3 Mechanical Integrity

104. *All wells within the AOR, including the observation, hydraulic control, and POC wells will require Part 1 mechanical integrity testing to detect casing and/or tubing and packer leaks and to ensure isolation of the injection zone and prevention of the entry of other formation fluids. Part II mechanical integrity testing of all wells within the AOR, including observation, hydraulic control, and POC wells, will be required to ensure an adequate seal for containment of formation fluids and isolation of the bedrock injection zone. Please revise this section accordingly.*

2.4 Part 1 Mechanical Integrity Requirement

105. *As noted above, EPA will require Part 1 mechanical Integrity testing at least once every five years until a well is plugged and abandoned in accordance with UIC permit conditions. This requirement applies to all wells within the AOR, including POC wells. Please revise this section accordingly.*

2.5 Groundwater Monitoring

2.5.1 Monitoring Locations:

106. *The location and number of monitoring (POC) wells is also subject to UIC permit conditions. Please include the schedule for POC installation in Attachment P of the UIC permit application. The POC wells should be located within the AOR boundary, rather than just outside the AOR and aquifer exemption boundary, to confirm that there is no migration of contaminants into the USDW located beyond the AE boundary. Please revise Section 2.5 in accordance with these requirements.*

2.5.2 Monitoring Parameters:

107. It is not clear that the application proposes AWQSs/maximum contaminant levels (MCLs) or ambient water quality levels or some combination of those parameters as the basis for aquifer quality limits (AQLs).

The revised application should clarify that AQLs will be established based on federal MCLs.

2.6 Hydraulic Control Monitoring

2.6.1 Fluid Levels:

108. A slightly higher water level in the outer observation well than in the inner observation well will not suffice as a satisfactory demonstration of hydraulic control. The UIC permit will establish a minimum water level differential between observation well pairs to define hydraulic control, subject to adjustment based on observation of natural water level measurement variation and statistical noise levels in the measurements. *Please revise the Section, accordingly.*

2.6.2 Specific Conductance Monitoring:

109. Collecting grab samples for measurement of specific conductance in the field is not adequate for conductivity monitoring.

The revised application should include proposed installation of conductivity sensors in observation well screens at appropriate intervals to provide real-time monitoring of conductivity of formation fluids at the observation wells. The permit will require monitoring and recording of ambient conductivity levels before injection commences for comparison with levels recorded during ISR operations.

2.6.3 Injection vs. Extraction Volumes:

110. A minimum net pumping volume in the wellfield will be established as a permit condition, subject to adjustment based on observation well water level and conductivity data and EPA approval. *Please revise the section, accordingly.*

111. As noted above, a 30-day rolling average of total volume of injected fluids and total volume of recovered fluids as a basis for maintaining hydraulic control is not adequate. UIC permit conditions will likely require remedial action after 48 hours of a net imbalance of injection to extraction volumes based on a minimum ratio of over-extraction to injection volumes as discussed above. *Please revise this section, accordingly.*

Table P-1 and Figure P-1, POC, Observation, and Hydraulic Control Well Locations

112. *The revised UIC application should include additional observation and hydraulic control wells at the northwestern and southern boundaries of the northwestern part of the proposed*

wellfield and at the western limits of the southern part of the wellfield, as discussed above in the comments on AOR delineation in Attachment A. It should also include additional POC wells at the AOR boundary east and south of the eastern portion of the wellfield in Section 31 and at least three POC wells placed around the western boundary of the enlarged AOR in Section 36, as discussed above in comments on Attachment A. Please provide a justification for your proposed locations.

Attachment Q-1, Plugging and Abandonment Plan

2. Licensure and Permitting

2.2 Abandonment Notification and Authorization

113. *The revised UIC application should include a Plugging and Abandonment (P&A) Plan (Form 7520-14) for a typical POC well in Attachment Q-2. The UIC permit will require that P&A Plans are updated for actual construction and conditions in each well and that they are submitted to EPA at least 60 days in advance of P&A operations.*

3. Well and Borehole Abandonment Procedures

3.1 General Procedure for Plugging and Abandonment

114. *Please add "and UIC permit conditions" to the end of the sentence in Section 3.1.*

3.1.1 Well and Borehole Preparation

115. For the Casing/Screen: *Please revise the first sentence to state that "all" wells will be grouted to 100 feet above the bedrock contact or groundwater surface, whichever is shallower.*

Attachment Q-2, ADWR Well Abandonment Handbook and Example ADWR Notice of Intent to Abandon Form.

116. *Please include in the title for this attachment "Plugging and Abandonment Plans (EPA Form 7520-14)"*

117. *Please provide a cost estimate to plug wells and certification name, signature, and date on each P&A Plan form and correct the surface location description for section 36 to Range 22E on each form.*

118. *Please provide a P&A form for POC monitoring wells.*

119. *Please provide well schematics showing depths of cement plugs to be placed in each well type.*

120. *Please provide in Attachment Q a detailed description of the aquifer restoration plan for aquifer cleanup and monitoring to demonstrate adequate protection of USDWs.*

Attachment R-1, Necessary Resources

1. Necessary Resources

1.3 Proposed Financial Mechanism

121. The final sentence in this section states that "No facility will be ***operated*** until financial assurance is in place." Language at 40 CFR Part 146.34(a) (15) states that new Class III wells shall not be c***onstructed*** before the Director has considered the resources to plug, or abandon the wells. *Please revise this statement to replace "operated" with "constructed".*

Attachment R-2, Demonstration of financial Capability

122. The Excelsior letter for demonstration of financial capability dated January 4, 2016 is addressed to ADEQ.

    EPA will require financial assurance for UIC regulated facilities, independent of any other financial assurance that may be established with other regulatory entities. The revised application should include your proposed method for providing financial assurance to EPA.

Attachment R-3. Wellfield Closure Costs, Appendix M

Appendix M, Closure of ISR Wellfield

123. *Please add "and EPA requirements" after "in accordance with ADWR criteria" in the last paragraph of this section.*

Fixed Closure Costs

124. Reference is made to a third-party contract option on page M-3. *Please provide the closure cost estimates based on a third-party contract to close the ISR wellfields.*

Variable Closure Costs

125. The application states on page M-5 that "[a]pproximately 10 percent of the recovery wells in each rinsing block will be sampled prior to abandonment." All of the recovery wells will need to be sampled prior to abandonment. Additional sampling will be required at wells that fail the restoration standards. The verification sampling costs in Table M-7 do not account for those costs.

    The revised UIC application should clarify that "100 percent of recovery wells in each rinsing block will be sampled prior to abandonment." Also, please revise the verification sampling cost estimates in table M-7 accordingly and account for more than one round of sampling at wells that require more rinsing prior to abandonment of the wells.

Table M-9, Stage 1 Cumulative Wellfield Closure Liability by Production Year

126. The table omits contingency costs for unforeseen complications and additional costs to rinse and close wellfields if the planned five pore volumes of rinsing is insufficient. In addition, it appears that closure costs for POC monitoring, hydraulic control, and observation wells related to the Stage 1 wellfield are not included in the well abandonment costs. The cost estimates are based on costs incurred by the operator to close rather than a third-party contractor.

The revised UIC application should ensure that all contingency cost estimates and closure cost estimates for POC, hydraulic control, and observation wells are included in Table M-9 and present closure cost estimates based on third-party contractor costs.

Attachment S-1, Aquifer Exemptions

2. Exemption Criteria and Considerations

<u>2.1 Source of Drinking Water</u>

127. The statement that there are no active, producing water supply wells within one mile of the Project boundary as shown in Attachment B is not supported by information provided in Attachment B. There is a statement that there are no known producing wells, presumably within ½ mile of the property boundary since Table B-1 is a listing of wells within ½ mile of the property boundary and Figure B-2 is a map of wells located within ½ mile of the property boundary. There are numerous exempt and non-exempt water supply wells listed in Table B-1, but the status is not provided for those wells as active, producing, inactive, or abandoned.

The revised UIC application should clarify the statement to accurately represent the information provided in Attachment B and verify that none of the water supply wells are currently active or producing. Furthermore, please add the status of water supply and other wells listed in Table B-1 to the table.

4. Proposed Area of Exemption.

128. The proposed top of the aquifer exemption zone is the top of the bedrock, and the proposed bottom of the aquifer exemption zone is the top of the sulfide zone. The application states that the basin fill is not included in the proposed aquifer exemption zone because there are only relatively thin, isolated occurrences of saturated basin fill within the proposed AOR and that the saturated fill does not contain a "sufficient quantity of groundwater to supply a public water system." However, the lowermost 30- to 40-feet of basin fill sediments were saturated in two boreholes in the six-well 2011-2012 basin fill drilling program. One of the wells was reportedly dry in the basin fill and the other three wells were not drilled because saturated alluvium was not observed during the drilling of nearby bedrock wells.

The E-logs of two boreholes, apparently located within the AOR, indicate water levels in the open borehole within 20 feet of the surface and apparent water saturation in the basin fill up to within 50 feet of the surface, as discussed above in comments on Attachment N. The basin fill saturated thickness, as depicted in Figure 9 in Attachment A-3, shows the aquifer limit at or within the eastern boundary of the proposed AOR. Other comments provided above on Attachments A, B, C, D, and N of the application, related to the proposed aquifer exemption, raise concerns about exclusion of the saturated portion of the basin fill from the vertical aquifer exemption zone. The application fails to provide an adequate demonstration for exclusion of the saturated portion of the basin fill within the AOR from the aquifer exemption.

The top of bedrock is proposed as the upper limit of the aquifer exemption, but the uppermost bedrock layer is depicted as unsaturated in portions of the exempted area shown in the geologic cross sections in Figures S-6, S-7, and S-8. Since unsaturated portions of the uppermost bedrock zone are included in the aquifer exempted zone, it would seem logical to include the lowermost basin fill in the exempted zone where saturated and in hydraulic connection with the bedrock saturation. Based on the location of the potentiometric surface depicted in the cross sections and the apparent contact of the basin fill saturation with the bedrock saturation, it would appear that the basin fill and bedrock saturated sections consist of a single connected aquifer, albeit with different hydrogeologic properties.

The revised UIC application should address comments described above, including why the basin fill saturation should not be classified as a portion of a USDW, whether it is the uppermost limit of the USDW in the underlying bedrock, or an extension of the basin fill USDW as depicted in Figure 9 of Attachment A-3.

129. Estimated K values in the sulfide zone ranges from 0.001 to 0.1 ft/day, based on aquifer pumping tests in two wells performed in 2015. The application states that "the sulfide zone is considered not feasible as an aquifer for a public water supply, and it provides a site specific control on the vertical migration of injected solutions." These K values represent a range of up to two orders of magnitude and the highest K value of 0.1 ft/day could be considered as borderline productive. Furthermore, the presence of vertical faults extending from the sulfide zone into the above oxide zone appear to provide a transmissive hydraulic connection between zones. There is no continuous lithologic boundary between the oxide and sulfide zone and the only barrier to flow between zones appears to be an area of lower intensity fracturing in the sulfide zone relative to the oxide zone. Consequently, the applicant has not provided an adequate demonstration that the sulfide zone is not a USDW and not hydraulically connected to the overlying oxide USDW.

The revised UIC application should either provide a more justified assessment to consider the sulfide zone as an underlying confining zone (aquiclude) to the oxide zone and its suitability as the lower boundary of the proposed aquifer exemption, or include the transition zone and upper portion of the sulfide zone in the proposed aquifer exemption.

Figure S- 9, Area of Exemption

130. The wellfield boundary is not included in the legend, and the AOR/AE boundary does not account for possible excursions beyond the wellfield at the proposed southern and western limits of the AOR/AE during ISR and rinsing operations, regardless of the natural groundwater flow direction.

The revised UIC application should add the wellfield boundary to the legend. As noted in comment 45, we recommend expanding the AOR and aquifer exemption limits, assuming the federal criteria can be met for the exemption, beyond the wellfield perimeter at the proposed southern and western boundary by at least 500 feet to provide a buffer zone for a potential temporary loss of hydraulic containment and excursion of ISR fluids during ISR and rinsing operations.